

**ISyE 7201A Production & Service Systems Engineering**  
**Spring 2019**  
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**Course Meeting Times:** MW 12:20-1:35pm

**Course Classroom:** Groseclose 402

**Instructor Office Hours:** By appointment

### **Course Objective**

This course seeks to familiarize the students with an array of problems and methods that pertain to the modeling, analysis and control of contemporary production and service systems. More specifically, it is expected that by the end of this course, the students will have

- a profound understanding and appreciation of the different resource allocation and coordination problems that underlie the behavioral management and the performance enhancement of the considered class of systems;
- the ability to formally characterize and study these problems by referring them to pertinent analytical abstractions and modeling frameworks;
- an appreciation of the inherent complexity of (many of) these problems, the complications arising from this complexity, the resulting need for simplifying approximations, and the ensuing trade-off between modeling accuracy and computational / analytical tractability;
- familiarity with some typical approaches for developing pertinent approximations for the considered class of problems;
- an understanding and appreciation of the multi-faceted role of simulation in the study of the considered systems.

Furthermore, it is expected that the aforementioned experience will

- define a “research frontier” for the addressed areas, and in this way,
- assist the students in developing the perspectives and strengthening the skills that are necessary for the definition and successful execution of a Ph.D. research program.

### **Tentative Course Outline**

1. Introduction: Course Objectives, Context, and Outline
  - Contemporary organizations and the role of Operations Management (OM)
  - Corporate strategy and its connection to operations
  - The organization as a resource allocation system (RAS)
  - The underlying RAS management problems and the need for understanding the impact of the underlying stochasticity
  - The basic course structure
2. Modeling and Analysis of Production and Service Systems as Continuous-Time Markov Chains
  - A brief overview of the key results of the theory of Discrete-Time Markov Chains
  - Bucket Brigades
  - The Exponential Distribution and the Poisson Process
  - Continuous-Time Markov Chains (CT-MC)
  - Birth-Death Processes and the M/M/1 Queue
    - Transient Analysis
    - Steady State Analysis
  - Modeling more complex behavior through CT-MCs

- Single station systems with multi-stage processing, finite resources and/or blocking effects
  - Open (Jackson) and Closed (Gordon-Newell) Queueing networks
3. Accommodating non-Markovian behavior
    - Phase-type distributions and their role as approximating distributions
    - The M/G/1 queue
    - Priority Queues
    - The G/G/1 queue
    - The essence of “Factory Physics”
    - (Reversibility and BCMP networks)
  4. Performance Control of Production and Service systems
    - Controlling the “event rates” of the underlying CT-MC model (an informal introduction of the dual Linear Programming formulation in standard MDP theory)
    - A brief introduction of the theory of Markov Decision Processes (MDPs) and of Dynamic Programming (DP)
    - An introduction to Approximate DP
    - An introduction to dispatching rules and classical scheduling theory
    - Buffer-based priority scheduling policies, Meyn and Kumar’s performance bounds and stability theory
  5. Behavioral Control of Production and Service Systems
    - Behavioral modeling and analysis of Production and Service Systems
    - Resource allocation deadlock and the need for liveness-enforcing supervision (LES)
    - Petri nets as a modeling and analysis tool
    - A brief introduction to the behavioral control of Production and Service Systems

**Course Prerequisites:** Familiarity with Stochastic / Probabilistic Modeling and Deterministic Optimization at the respective levels of ISYE 6761 and ISYE 6669.

### Course Reading Material

**Textbook:** *Fundamentals of Queueing Theory (4<sup>th</sup> ed.)*, by D. Gross, J. F. Shortle, J. M. Thompson and C. M. Harris, John Wiley & Sons, Inc., 2008.

The above text will function as a “base” for the presented developments. Additional supplementary material will be provided either in class, or through a course website accessed from the instructor homepage, or through the library electronic reserves (in case that copyright clearance is necessary).

### Course Policies

**Homework:** I shall circulate “homework” for various parts of the course together with its solutions. This material intends to help you internalize the course lectures, but many of the provided problems have significant theoretical interest themselves, as they extend the basic theory covered in class in various directions.

**Exams:** There will be two midterms and a final exam. The exact date and the material to be covered by the midterm exams will be determined as the course progresses. The final exam will be comprehensive. Obviously, you are expected to observe the *Georgia Tech Honor Code* while taking the exams (*and no collaboration or any other interactions will be allowed during the exams!*)

**Grading:**

- Homework: 00%
- Two Midterm Exams: 30% each
- Final Exam: 40%